

## **CLAIMS**

What is claimed is:

1. A high pressure apparatus, comprising:
  - a) a plurality of complementary die segments, each die segment having  
5 an inner surface and an outer surface, wherein the inner surfaces are configured to form a die chamber having a chamber axis upon assembly of the plurality of die segments;
  - b) a pair of anvils oriented such that an anvil is at each end of the die chamber and configured to apply force substantially along the chamber axis; and
  - 10 c) a plurality of force members operatively connected to the plurality of die segments and configured to apply a plurality of discrete forces to the plurality of die segments sufficient to retain the plurality of die segments in substantially fixed positions relative to each other during application of force by the pair of anvils.
- 15 2. The apparatus of claim 1, wherein the inner surfaces of the plurality of die segments are arcuate and when assembled, form a die chamber having a central cylindrical volume and expanded open conical regions at each end of the cylindrical volume.
- 20 3. The apparatus of claim 2, comprising from two to ten complementary die segments.
4. The apparatus of claim 3, comprising two complementary die segments.
- 25 5. The apparatus of claim 3, comprising four complementary die segments.
6. The apparatus of claim 4, wherein the die chamber has a length of from about 1 to about 10 times the minimum diameter.
- 30 7. The apparatus of claim 1, wherein the inner surfaces of the plurality of die segments are substantially flat and when assembled, form a die chamber having a central rectangular volume and open regions tapered outwardly at each end of the rectangular volume.

8. The apparatus of claim 7, comprising four die segments.
9. The apparatus of claim 1, wherein the outer surfaces of the plurality of die  
5 segments are attached to a plurality of support members.
10. The apparatus of claim 9, wherein the force members are pairs of platen in a  
uniaxial press and wherein a pair of support members are operatively connected to  
respective pairs of platen in each of at least one uniaxial press.
- 10 11. The apparatus of claim 10, wherein two die segments are attached to each  
support member.
12. The apparatus of claim 9, wherein the die segments and support members are  
15 integrally formed of a single piece.
13. The apparatus of claim 9, wherein the plurality of support members have an  
outer surface opposite the die segments, wherein the outer surface is inwardly  
contoured to form a profile configured to reduce tensile stress in the die segment.
- 20 14. The apparatus of claim 9, wherein the die segments and support members have  
contoured contact surfaces which are configured to control pressure distribution along  
the contact surfaces and further comprises corresponding contoured gaskets  
configured for placement along the contact surfaces.
- 25 15. The apparatus of claim 1, wherein the discrete forces intersect at a common  
point and act in a common plane substantially perpendicular to the chamber axis.
16. The apparatus of claim 15, wherein the discrete forces are greater than the  
30 force applied by the pair of anvils.
17. The apparatus of claim 1, wherein the pair of anvils are frustoconical anvils.

18. The apparatus of claim 1, wherein the die chamber has a reaction volume from about 10 cm<sup>3</sup> to about 500 cm<sup>3</sup>.
19. The apparatus of claim 1, wherein the chamber axis is oriented horizontally.
- 5 20. A method of applying high pressures to a high pressure assembly, comprising:
- a) assembling a plurality of die segments to form a die chamber having a chamber axis and being configured to hold the high pressure assembly; and
  - b) applying a pressing force to the high pressure assembly substantially
- 10 along the chamber axis which is sufficient to provide high pressures within the high pressure assembly while retaining the plurality of die segments in substantially fixed positions relative to each other, using a plurality of discrete forces, said discrete forces intersecting at a common point and acting in a common plane substantially perpendicular to the chamber axis.
- 15 21. The method of claim 20, further comprising the step of orienting said die chamber horizontally prior to applying a force to the high pressure assembly.
22. The method of claim 20, wherein the pressing force is sufficient to provide
- 20 ultrahigh pressures.
23. The method of claim 20, wherein the ultrahigh pressures are from about 4 GPa to about 6 GPa.
- 25 24. The method of claim 20, wherein the step of applying force is accomplished by a pair of anvils placed at either end of the die chamber.
25. The method of claim 20, wherein the plurality of discrete forces are greater than the pressing force.
- 30 26. The method of claim 20, wherein the plurality of discrete forces is applied using at least one uniaxial press.